Compass & Tape

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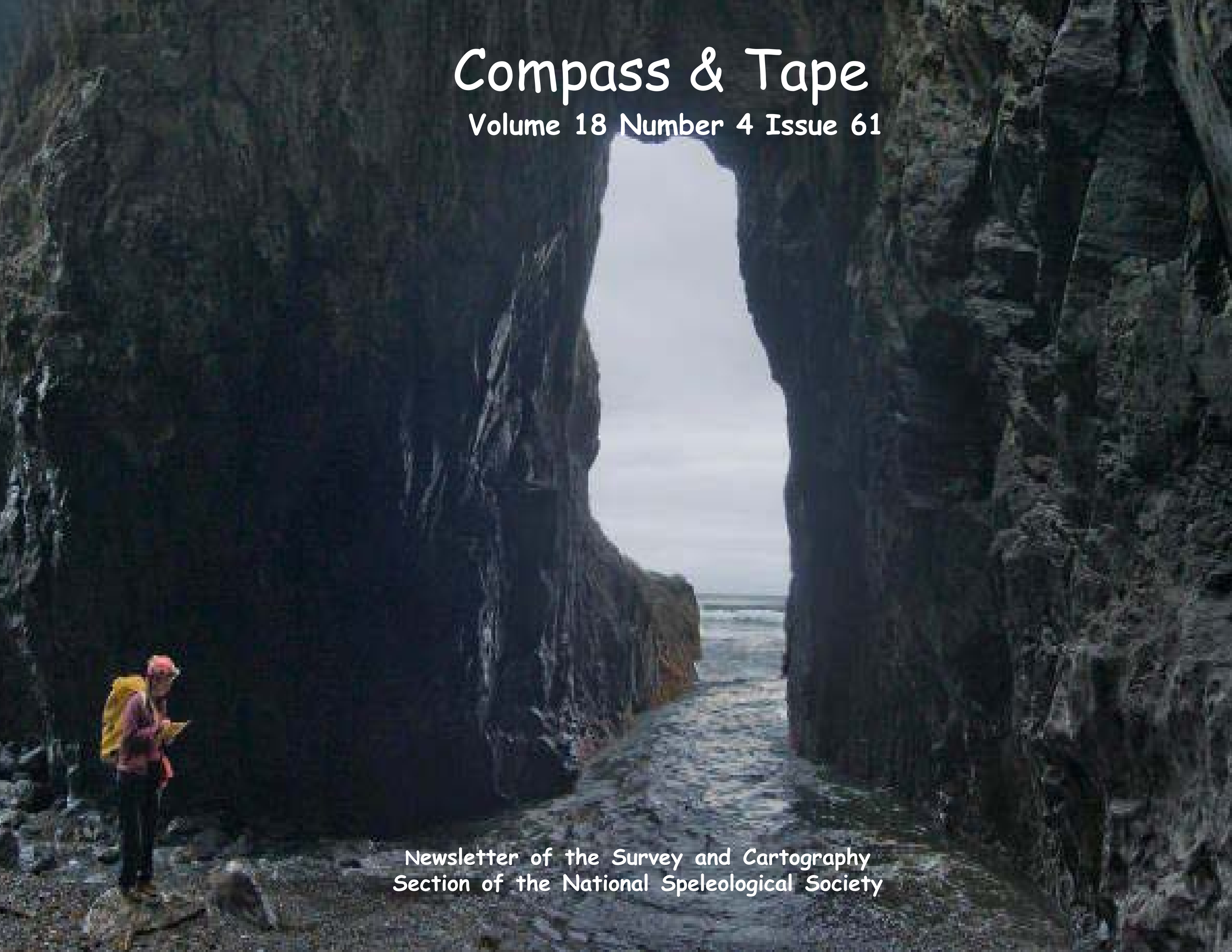

Newsletter of the Survey and Cartography Section of the National Speleological Society

Survey and Cartography Section

The Survey and Cartography Section (SACS) is an internal organization of the NSS that is devoted to improving the state of cave documentation and survey, cave data archiving and management, and of all forms of cave cartography.

Membership: Membership in the Section is open to anyone who is interested in surveying and documenting caves, management and archiving of cave data and in all forms of cave cartography. Membership in the National Speleological Society is not required.

Dues: Dues are $4.00 per year and includes four issue of *Compass & Tape.* Four issues of the section publication are scheduled to be published annually. However, if there are fewer, then all memberships will be extended to ensure that four issues are received. Dues can be paid in advance for up to 3 years ($12.00). Checks should be made payable to *"SACS"* and sent to the Treasurer.

Compass & Tape: This is the Section's publication and is mailed to all members. It is scheduled to be published on a quarterly basis, but if insufficient material is available for an issue, the quarterly schedule may not be met. *Compass* & *Tape* includes articles covering a wide range of topics, including equipment reviews, techniques, computer processing, mapping standards, artistic techniques, all forms of cave cartography and publications of interest and appropriate material reprinted from national and international publications. It is one of the media for conveying information and ideas within the U.S. cave mapping community. All members are strongly encouraged to contribute material and to comment on published material.. Items for publication should be submitted to the Editor.

NSS Convention Session: SACS sponsors a Survey and Cartography session at each NSS Convention. Papers are presented on a variety of topics of interest to the cave mapper and cartographer. Everyone is welcome and encouraged to present a paper at the convention. Contact the Vice Chair for additional information about presenting a paper.

Annual Section Meeting: The Section holds its only formal meeting each year at the NSS Convention. Section business, including election of officers, is done at the meeting.

Back Issues: SACS started in 1983 and copies of back issues of *Compass & Tape* are available. The cost is $1.00 each for 1-2 back issues, $0.75 each for 3-6 back issues and $.50 each for more than six back issues at a time. Back issues can be ordered from the Treasurer.

Overseas Members: SACS welcomes members from foreign countries. The rate for all foreign members is US$4.00 per year and SACS pays the cost of surface mailing of *Compass & Tape*. If you need air mail delivery, please inquire about rates. All checks MUST be payable in US$ and drawn on a U.S. bank.

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Inside

Front Cover: Andrea Croskrey sketching at the sea arch in front of the entrance to Wooden Dragon Cave, Heceta Island, Alaska
Photo: Dave Bunnell

Back Cover: Map of Stairstep Cave, St. Phillip Parish, Barbados
Cartographer: P. Kambesis

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The editor reserves the right to select which of the submitted materials will be used for publication. Of the material selected, the editor reserves the right to delete redundant or inappropriate material, to correct errors of spelling, grammar, or punctuation, and to edit for clarity, so long as such alternations do not change the meaning or intent of the author(s). In the event that significant changes are contemplated, the author(s) will be consulted and given the opportunity to review the changes prior to publication.

Submissions

All types of materials related to cave survey and survey data, cartography, and cave documentation in general, are welcome for publication in *Compass & Tape.* Manuscripts are accepted in ANY form but are most welcome via email attachment or on CD's. Typed material is next best although we will accept handwritten material as long as it is legible. Artwork is any form. shape or size is also welcome. Send all submission for *Compass & Tape* to:

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Minutes of the NSS Survey & Cartography Section Annual Meeting NSS Convention, Kerrville, Texas July 25, 2009

Meeting called to order at 7:20am Minutes from 2008 were reviewed and motion to accept made by Thom Engel and seconded by Bob Hoke, motion passed.

Reports:
Presidents Report - none
Treasurer's report: none

Prizes purchased for cartographic salon went $100 over budget. Items purchased included Leica Disto's for merit awards, survey bags for honorable mention and a digital tablet for the medal.

Cartographic Salon:
Jim Kennedy reported that 66 maps were entered in the salon this year.

New Business:
Discussion ensued about potential digital entries and how they would be displayed. Suggestions were ade for renting an LCD projector and PC

There are currently no judging criteria for digital entries. Howard Kalnitz and Aaron Addison volunteered to work on guidelines for digital entries.

There were a number of cave atlas entries in this year's cartographic salon. Several of the judges put together new judging standards for these types of maps.

There was discussion on SACS representation for UIS. Pat Kambesis had been informally serving in that role. Motion by Howard Kalnitz for SACS to have an official representative, seconded by Carol Vesely. Motion was passed unanimously. Pat will continue to serve as SACS rep to UIS.

"Lightening Topics" organized by Kambesis and Kalnitz were very well attended. Speakers were Roger Brucker, Luc LeBlanc, Howard Kalnitz and Scott House. Its was suggested that we do same at future conventions.

Old Business:
It was suggested that all SACS presentations be made available online. Also, it would be good to find someone to do "pod casts" which could also be posted on the website. Aaron said he would try to find someone to do this.

George Dasher reports that the text review for the next version of On Station have been completed.

Discussion on renting for HDTV for next year's Salon. Jim Kennedy will talk to Carolina Shrewsbury about this. Another option is to leave a computer projector up and running.

Aaron Bird volunteered to scan issues of *Compass and Tape* to be posted online as PDF's.

Elections: Following was the slate of nominations for officers for the Survey and Cartography Section:
Aaron Addison - Chairman
Howard Kalnitz – Vice Chair
Bob Hoke –Treasurer
Pat Kambesis – Secretary

Since all officers are running unopposed, Motion was made to accept the entire slate.
Gulden Second – Motion passed.

Carol Vesely was selling raffle tickets to support donations for the Phillipines Cave Project, specifically to purchase survey gear for the Phillipino cavers. Tickets were $5.00/each.

Aasron Addison cave a map demonstration of Mapviewer, which can display large scale maps over the web. Maps are zoomable and there is scale and navigation controls. Map image is rasterized in Illustrator. Map layers can be used, attributes displayed and the maps can be password protected.

After the presentation, Pat Kambesis made a motion to adjourn the meeting which was seconded by George Dasher.

Meeting adjourned at 8:30am

ICS-NSS Cartographic Salon 2009

Co-Chairs: Jim Kennedy (USA) and Luc Le Blanc (Canada)

Sixty-six maps were entered in this year's salon, tying for the all-time record with the 1981 ICS in Bowling Green, Kentucky. Due to the international flavor of this year's salon competition, the usual Apprentice, Experienced, and Expert categories were suspended in favor of cave length catego-ries. Awards reflected ICS preferences, of 1st, SECOND, and THIRD for each category.

There were maps from Belize, China, Cuba, France, Gabon, Guatemala, Lao Peoples Democratic Republic, Mexico, Romania, Spain, and the United States (12 states: Alabama, Alaska, Colorado, Georgia, Hawaii, Kentucky, Montana, South Dakota, Tennessee, Texas, Virginia, and West Virginia). There were 33 cartographers represented, 3 more than the 1981 ICS.

This year, we instituted a **People's Choice** award by cavers' voting at the Cartography Salon for the first time. It encouraged more cavers to look at the maps carefully to cast their votes. Following are the map categories and awards:

<500m (<1640 feet): 14 Maps
JUDGES: Brent Aulenbach, Tudor Tamas, Ghada Salem

Accepted (white ribbon):
Chechebak, Yucatan, Mexico, by Jason Richards; *Cueva la Coyota*, San Luis Potosí, Mexico, by Roberto Legaspi Balderas; *Cueva Las Brujas*, Quintana Roo, Mexico, by Emiliano Monroy-Rios; *Cueva de los Cuarenta*, Andalusia, Spain, by Antonio Acalá Ortiz; *Cueva de Huerta Anguita*, Andalusia, Spain, by Antonio Acalá Ortiz; *Cueva Sara*, Yucatan, Mexico, by Jason Richards; *Doobie Pit*, Wayne County, Kentucky, by Robert Yuellig; *Heather's Grotto*, Kosciusko Island, Alaska, by Johanna Kovarik; *Kukula*, Yucatan, Mexico, by Jason Richards; *No Crawlway for Old Men/Fun 4 Kids Cave*, Garfield County, Colorado, by Andrea Croskrey; *Tixcacal*, Yucatan, Mexico, by Jason Richards

THIRD (green): *Chucky's Cave*, Edwards County, Texas, by Brian Alger

SECOND (green): *Dancing Cave System*, Bexar County, Texas, by Marvin Miller

FIRST (blue ribbon): *Wayback Cave*, White County, Tennessee, by Pat Kambesis

500–1000m (1640–3281 feet): 6 maps.
JUDGES: Howard Kalnitz, Johanna Kovarik

Accepted (white ribbon): *Clancy's Cave*, Meade County, Kentucky, by Jim Greer; *Cueva del Pirata*, Yaguajay, Cuba, by Mike Lace; *Pestera Magurici,* Transylvania, Romania, by Tudor Tamas

THIRD (green): *Midnight Terror Cave*, Springfield, Cayo District, Belize, by Nancy Pistole

SECOND (green): *Cuevas de Setzol*, Chahal, Alta Verapaz, Guatemala, by Nancy Pistole

FIRST (blue ribbon): *Sitting Bull Crystal Caverns*, Pennington County, South Dakota, by Andy Armstrong

1000–5000m (3281–16,404 feet): 19 maps.
JUDGES: Rod Horrocks, Scott House

Accepted (white ribbon): *Breezeway Cave*, El Paso County, Colorado, by Paul Burger; *Cave of the Winds*, El Paso County, Colorado, by Paul Burger; *Cueva de la Mina de Jarcas*, Andalusia, Spain, by Antonio Alcalá Ortiz; *Cueva de los Chivos*, Sancti Spiritus, Cuba, by Pat Kambesis; *Cueva Maria Teresa*, Sancti Spiritus, Cuba, by Joel Despain; *Cueva Sakutzul*, Alta Verapaz, Guatemala, by Nancy Pistole; *Fletchers Cave*, Monroe County, West Virginia, by George Dasher; *Fricks Cave*, Walker County, Georgia, by Brent Aulenbach; *Grotte de Mbdenaltembe*, Ngounié Province, Gabon, by Nancy Pistole; *Manu Nui Cave System*, Hawaii, Hawaii, by Peter Bosted & Ann Bosted; *Obscure Magnificence*, Jackson County, Alabama, by Pat Kambesis; *Powells Cave Sink Maze*, Menard County, Texas, by Marvin Miller; *Sinks and Rises Cave*, Jackson County, Kentucky, by Jim Greer; *Sinks of Gandy*, Randolph County, West Virginia, by George Dasher, *Schoolhouse Cave*, Pendleton County, West Virginia, by George Dasher

THIRD (green): *Fairy Cave*, Garfield County, Colorado, by Hazel Barton

THIRD (green): *Fox Mountain CavePreserve*, Dade County, Georgia, by Brent Aulenbach

SECOND (green): *Pestera IZA*, Muntii Rodnei, Romania, by Tudor Tamas

FIRST (blue ribbon): *Snake Well Complex*, Marion County, Tennessee, by Brent Aulenbach

5000–10,000m (16,404–32,808 feet): 9 maps
JUDGES: Hazel Barton, Bob Richards, Carol Vesely

Accepted (white ribbon): *Bowden Cave*, Randolph County, West Virginia, by Bob Gulden; *Buckeye Creek Cave System*, Greenbrier County, West Virginia, by George Dasher; *Cueva Charco*, Oaxaca, Mexico, by Nancy Pistole & Charley Savvas; *Great Onyx Cave*, Edmonson County, Kentucky, by Bob Gulden; *Jackpot Cave*, Edmonson County, Kentucky, by Steve Duncan ; *Sharps Cave*, Pocahontas County, West Virginia, by George Dasher

THIRD (green): *Tham Khoun Xe*, Khammouane Province, Lao Peoples Democratic Republic, by Robert Osburn

SECOND (green): *Sistema Boquerones*, Sancti Spiritus, Cuba, by Joel Despain

FIRST (blue ribbon): *Dry Cave*, Greenbrier County, West Virginia, by Charles Lucas & Phil Lucas

10,000m+ (32,808+ feet): 10 maps
JUDGES: Luc Le Blanc, Kevin Stafford

Accepted (white ribbon): *Gap Cave*, Lee County, Virginia, by Bob Gulden; *Grayson Gunnar Cave*, Wayne County, Kentucky, by Lacie Braley; *Grotte de Saint-Marcel-d'Ardeche,*, Ardeche, France, by Marc; *Helictite Cave*, Highland County, Virginia, by Phil Lucas; *San Wang Dòng*, Chongquing, Wulong County, China, by Anthony Day, Becka Lawson, Julian Todd, Julia Bradshaw, Duncan Collis, & Erin Lynch; *Steinbrückenhöhle*, Totes Gebirge, Austria, by Martin Green & David Loeffler; *Unthanks Cave*, Lee County, Virginia, by Tom Spina & Phil Lucas

THIRD (green): *Wind Cave*, Custer County, South Dakota, by Rodney Horrocks & Daniel Austin

SECOND (green): *Salts Cave*, Mammoth Cave System, Edmonson County, Kentucky, by Michael Sutton

FIRST (blue ribbon): *Qìkbbg Dòng & Dòngbà Dòng*, Chongquing, Wulong County, China, by Erin Lynch & Duncan Collis

Map Atlas: 4 maps
JUDGES: Pat Kambesis, Erin Lynch

Accepted (white ribbon): *Gap Cave*, Lee County, West Virginia, by Bob Gulden

THIRD (green): *Great Onyx Cave*, Edmonson County, Kentucky, by Bob Gulden

SECOND (green): *Cassell Cave*, Pocahontas County, West Virginia, by Robert Zimmerman

FIRST (blue ribbon): *Lewis & Clark Caverns*, Jefferson County, Montana, by Bob Richards

FIRST– BEST OF CARTOGRAPHY
Lewis & Clark Caverns, Jefferson County, Montana, by Bob Richards

Peoples Choice Award
Salts Cave, Mammoth Cave System, Edmonson County, Kentucky, by Michael Sutton

Survey Techniques for Xe Bang Fai River Cave
Laos People's Democratic Republic

by Aaron Addison

Editors Note: Xe Bang Fai River Cave, which has a drainage basin of over 1300 km^2 of drainage, is one of the largest active river cave passages in the world. The cave is well-known to the Lao people, and was first traversed in 1905 by French explorer Paul Macey. However the area remained virtually unknown to Westerners due to its remoteness, WWII and the IndoChina war, and its position on the Ho Chi Minh Trail. Claude Mouret visited the cave in 1995 after which the area was closed to foreigners. It was reopened to kayakers circa 2005, and a Canadian/American caving team regained access in 2006.

Xe Bang Fai is a massive river cave located in eastern Laos on its border with Vietnam. The initial visit by a Canadian/American team in 2006 made it clear that size of the cave might present unique survey challenges. It was not until their third day in the cave when they undertook a proof of technique survey that they realized just how big. Visual wall and ceiling distance estimates were half that measured by their laser distance meter. This place really was big!

The team had arrived with a standard array of cave survey gear including fiberglass measuring tapes, suunto compasses and inclinometers, clipboards and 8.5 x 11 inch gridded sketch paper, etc. Fortunately a Trimble HD150 laser distometer was also brought to the cave, as it proved to be an absolute necessity in measuring distances. Typically a cave survey team measures distance, bearing and inclination from point to point through the cave. A 20 to 50 meter fiberglass tape is typically used to measure distance and is often left on the floor for reference by the sketcher. Hand held compasses and inclinometers are used for bearing and vertical angle. Each survey shot is recorded and plotted to scale in a notebook (or in larger passages on 8.5 x 11 sheets). Walls, floor and ceiling detail and cross sections are added to the sketch page (also to scale) around the survey line. Ideally the team comes out of the cave with a somewhat rough but essentially complete map. A running profile is sometimes drawn when either floor or ceiling changes height significantly. The proof of technique survey revealed two difficulties. The 50 meter tape wasn't nearly long enough. It would not reach across the passage and would promptly disappear beneath the pervasive deep water, rendering it useless for sketching and very possibly permanently lost after the first slip. Even if the tape could be secured, the submerged portion of the tape would be pushed downstream by the current. The tape was promptly abandoned for the laser distance meter which helped but was not perfect. Sixty meter shots were reliable from this unit under in cave conditions.

Survey was possible, but still longer distances could not be measured and therefore stations were not efficiently or optimally placed. The second obvious problem was the scale at which to represent the cave passage on the sketch. Most caves are sketched at scales from 1:250 up to 1:600 but in this case to the enormity of the trunk passage dictated the use of 1:1000 simply to allow the passage to fit on the width of the paper. A final problem that had not been anticipated was team communication. Operating from boats 50 meters apart made talking difficult and near impossible near the rapids throughout the cave. The two person team surveyed about 800 meters and concluded it could be done to a reasonable standard with a larger team, more time and a longer range measuring device.

An international team of eight cavers, 4 Canadian and 4 American returned in 2008 with

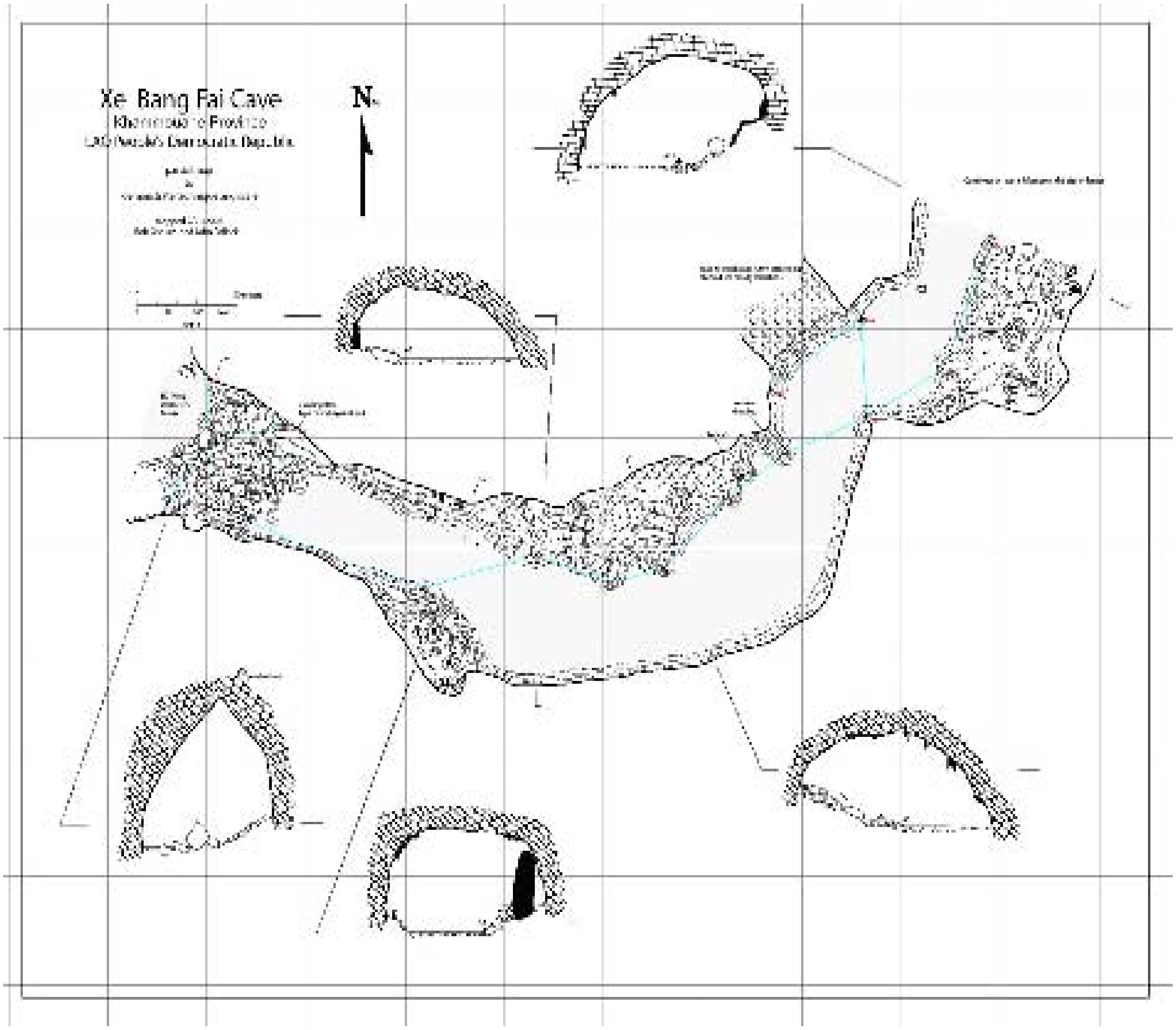


Figure 1. Map from the 2006 survey effort.

more robust measuring instruments and assorted survey gear. The technique from 2006 had produced a sketch from which a decent map could be made (Figure 1) and the only substantially improvement needed was better distance measuring instruments.

The team had acquired a pulse laser device (Impluse 200xl) capable of reliable distance readings to at least several hundred meters] The instrument is also constructed and sealed to military specifications and thus capable of surviving a very wet cave environment. The team also acquired two additional laser distometers for wall distance measurements. To address the communication challenges a number of small FM radios were added to each team gear set. Radios working in caves may not be commonplace, but they are line of sight and in big passage worked very well over the distances needed. Surveying was done as a team of 4 (in two boats) most of the time but separated into 2 person teams in the smaller dry side passages. The forward team (boat) set point, recorded numbers and drafted cross sections and profile; the person not drawing was free to scout possible new passages. The rear team operated the instruments giving distance, bearing and inclination and drafted the plan view. The impulse was operated either on a staff where dry land was

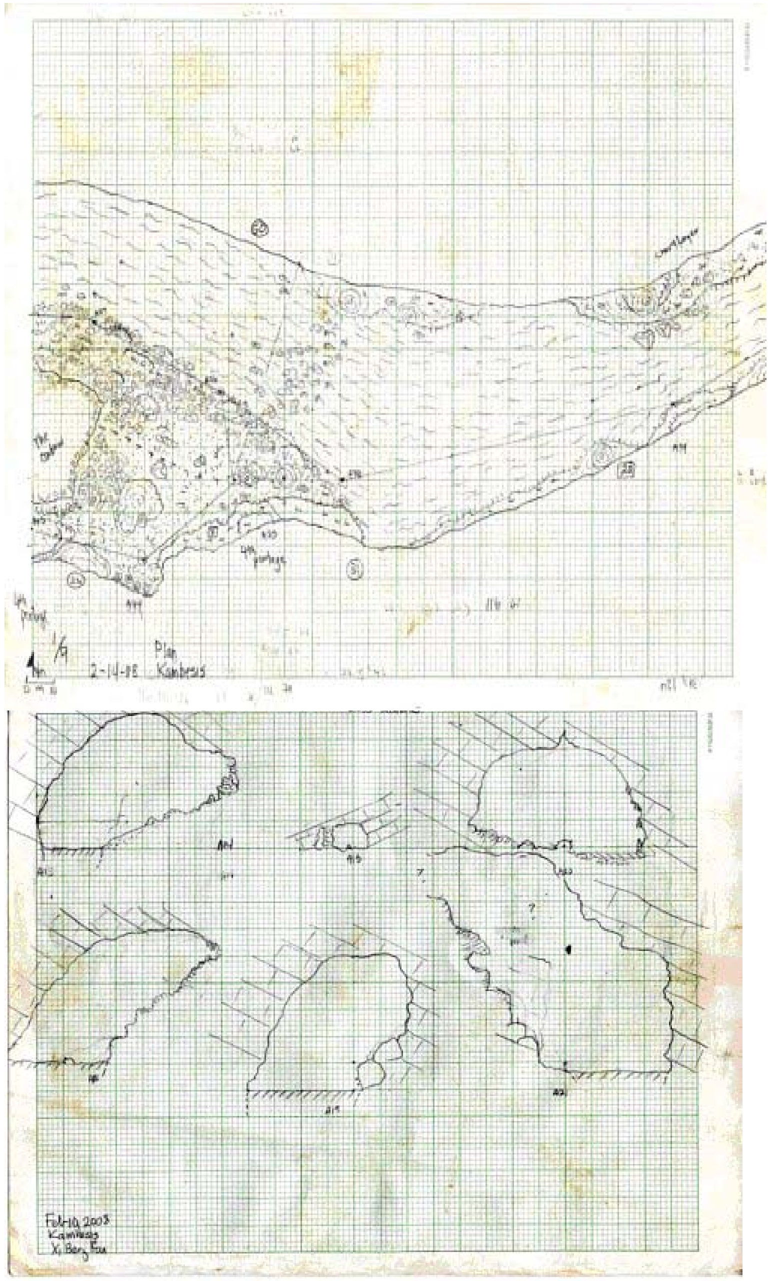


Figure 2. Section of plan view and cross sections for Xe Bang Fai.

available or handheld and steadied against a rock or the wall where leaving the boat was not practical The plan sketch, the most mentally demanding job, often fell to Pat Kambesis based on her experience and mental toughness. The Impluse 200xl's ability to measure longer distances made all the difference in the ability to survey in a passage so big and wet. Shots could be placed where they were needed rather on the rock or ledge you could reach and passage dimensions could be reliably measured. And once the technique was worked out the technique was fast and repeatable. Survey shot lengths in excess of 100m proved to be reasonable in a 50m - 70m wide flooded passage with few rocks or ledges to use for stations. Several survey measurements were as much as 150m, with a maximum length of 180m. The nine days of field work yielded 13.8 km of survey of which 11 km was passage survey and the other 2.8km was infill survey in large rooms. Without the impulse our productivity would have been cut in half as we worried our way up the passage unable to reach reasonable stations.

How I Learned to Love Cross Sections

Testimonial from a survivor of GCSS
by Jeff Bartlett

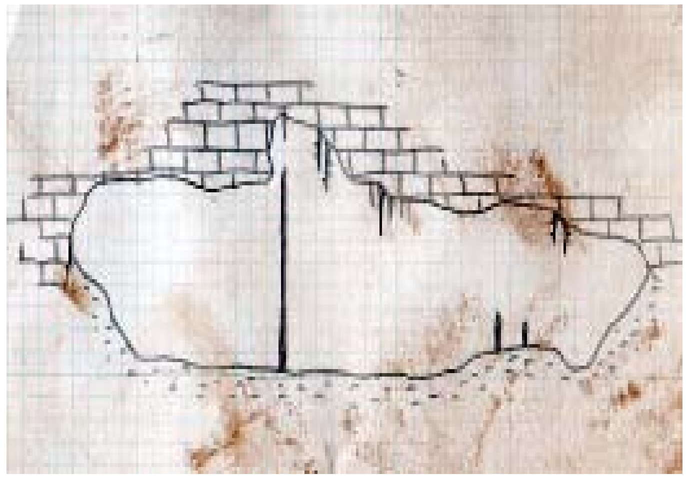
Reprinted with permission from ArkansasUnderground, April 2009

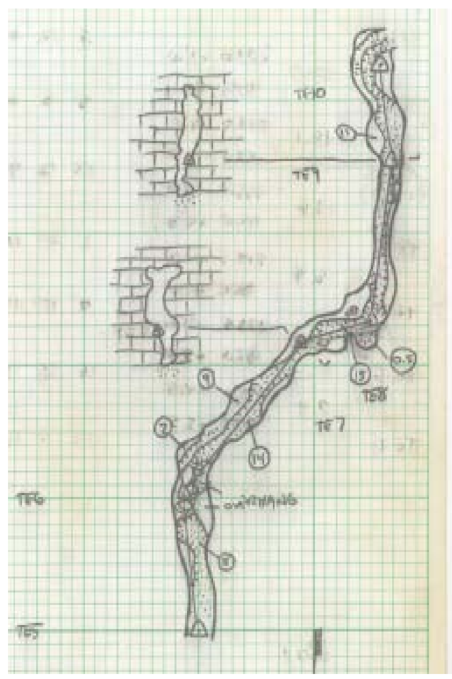
The Affliction.

In spring of 2008, I was diagnosed with Gutless Cross-Section Syndrome (GCSS). At the time, I had sent some sketches to *CRF's* chief cartographer, Bob Osburn, with hope of being approved for sketching in Mammoth Cave. I received the approval. But, along with other suggestions on how to improve my work, Bob pointed out the clear symptoms of my malady: in
the example I'd provided, three passages converged in a tall room, and I'd drawn cross-sections in each of the three (none of which were particularly unique) without giving any thought to the room.

He was right! I'd fallen into an obvious trap. I'd followed the path of least resistance. With 2 or 3 crosssections per page of sketch, who could complain?Besides, cross-sections are a pain, right? You have to switch gears, mentally, from drawing the plan view in order to do them, and then you have to switch right back. I viewed them as speed bumps, necessary evils slowing down my survey pace.

Soon, I saw the error of my ways, and with therapy my GCSS symptoms began to subside. Cross-sections became not a quota to meet, but a riddle to solve. In fact, not only was I cured of gutlessness, they are now my favorite part of sketching and drawing maps.

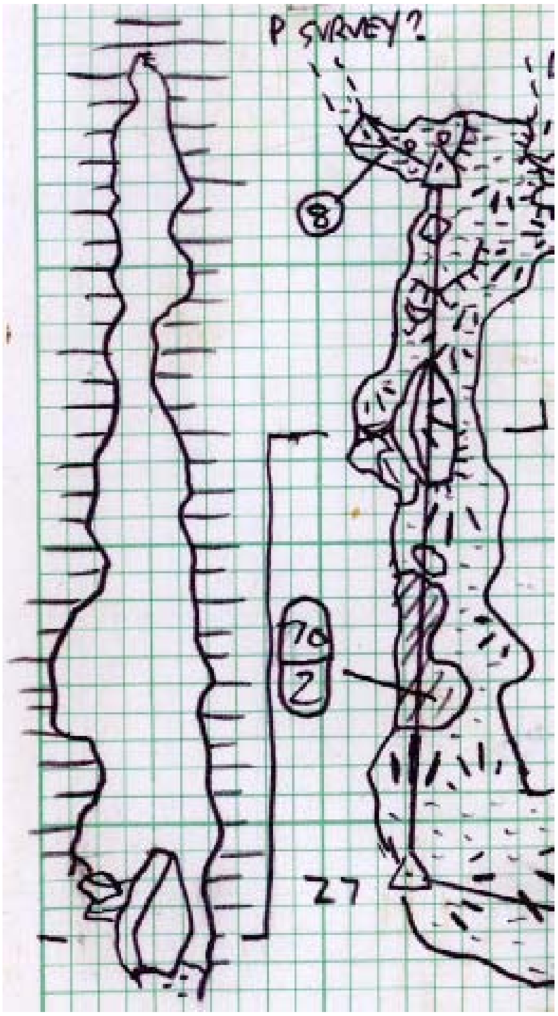


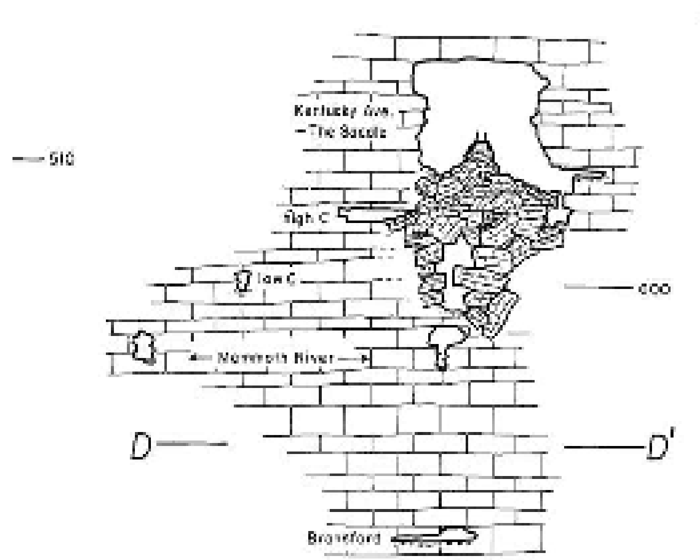


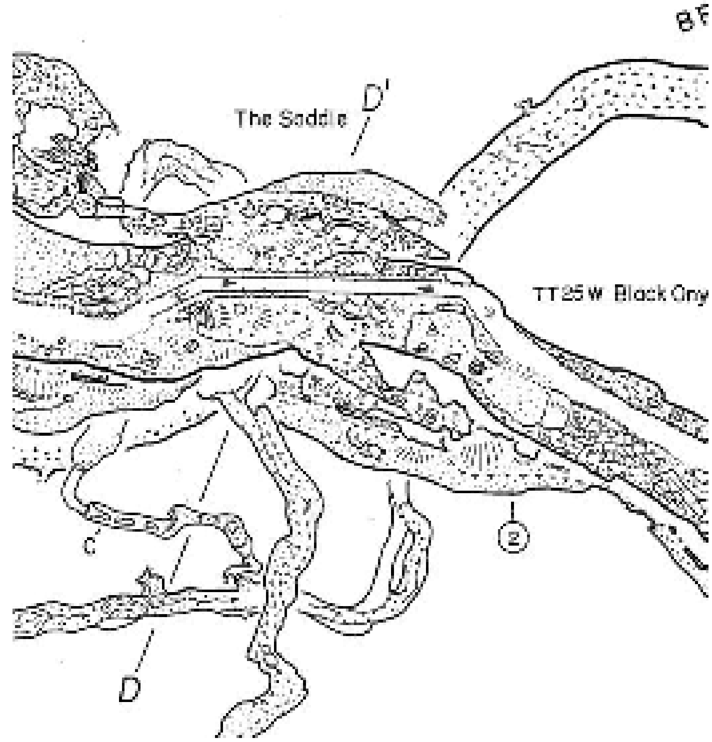
In some situations, a cross-section can express a cave feature much more clearly than the plan view. How better to describe an 18' tall totem pole? Bottom - In canyon passages, where it's often difficult to define walls on multiple levels (or explain different types of ledges), frequent crosssections cut to the chase. (J. Bartlett, Chinn Springs Cave, AR, 2009.)

The Challenge.

Sketching is the translation of a three-dimensional cave into a variety of two-dimensional



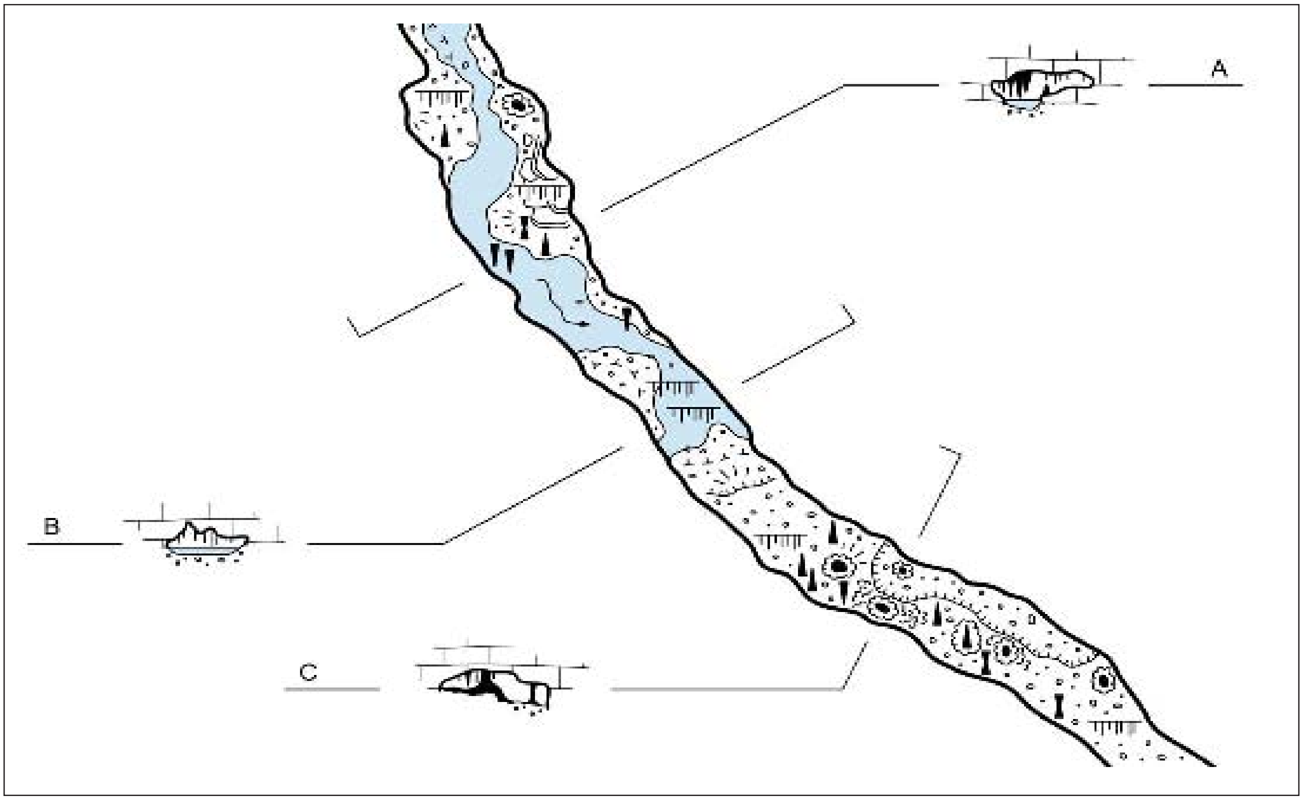




forms, and as much of the effort goes into the translation itself as does the physical act of drawing each line. The more complex the passage, the more difficult the sketching becomes. Frequently, features are encountered that give the sketcher pause. This protruding ledge… is that drawn as a ceiling drop or a floor drop? After all, depending on one's perspective, you can be either above or below it. That horrifying jumble of chocked breakdown in the ceiling… how do I draw this noteworthy feature without obscuring the plan view below it?

Often the answer to these cartographic questions lieswith the cross-section. After all, when the cartographer drafts a cave survey, he or she is attempting to explain the cave to the map viewer; In order for this to derstand what has been recorded by the sketcher. This is one reason it is most helpful

Top left - Since they mimic the caver's perspective of a passage, cross-sections can be more explicit than symbols on the plan views. Sure, the height bubble points out that this passage is 70' high, but the cross-section hammers it home. (J. Bartlett, Mammoth Cave 2009)
Top right - Large upper passages that obscure those below only worsen an already complicated cartographic situation. Offsets can show the obscured passages, but to adequately express the relationships from passage to passage, the only suitable option is a composite cross-section. (Mick Sutton, Mammoth Cave, 1992)



`Above - Often, the cross-sections are necessary to finish the thought. Without cross sections (ceiling heights intentionally omitted), the passage looks like a wet, chert-floored stream passage with quite a few formations. Add them in, and your map readers will probably notice that A and B require fullbody immersion to prevent damage to delicate features! (J. Bartlett, South Fork Cave, 2008)`

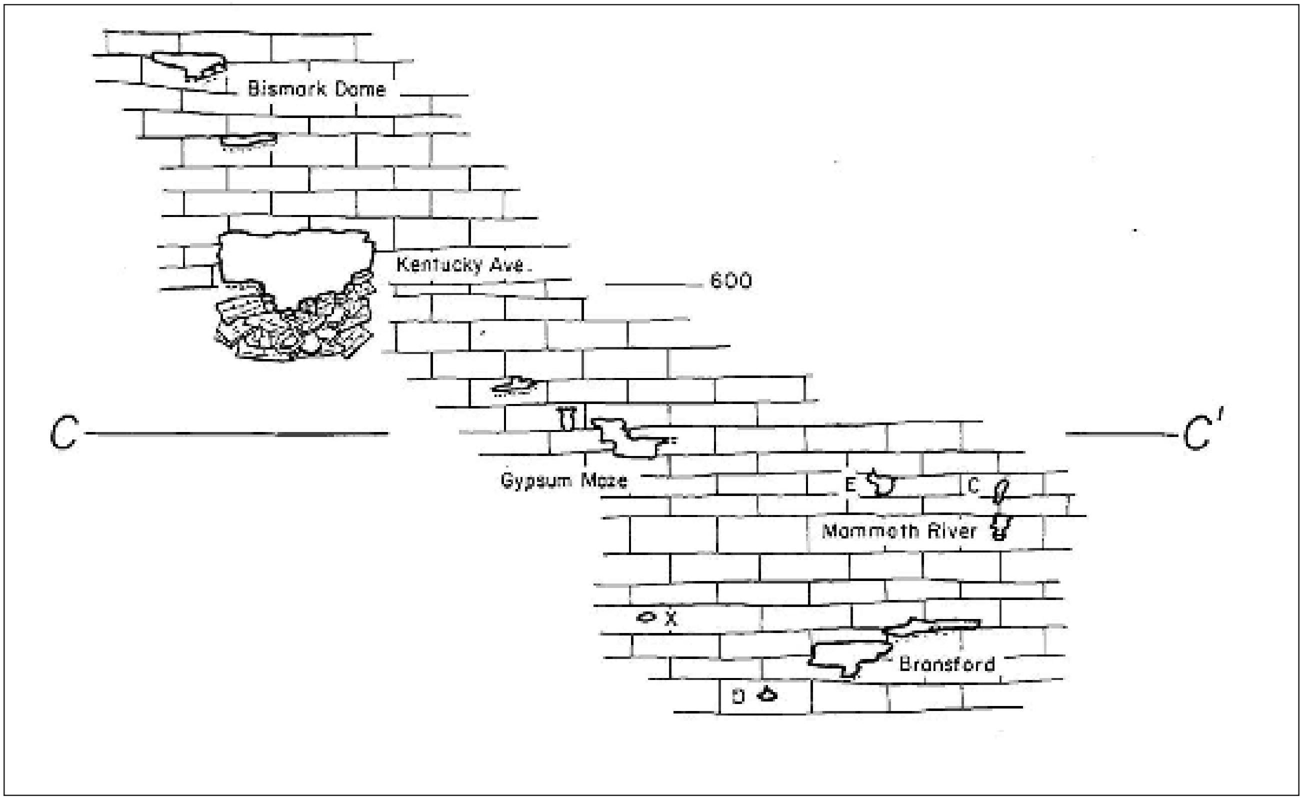
to have cross-sections at each station, and even at interesting features between stations. An abundance of cross-sections helps the cartographer comprehend the nature of the cave passage without a field check, and this comprehension allows good decisions to be made about how to represent the passages and rooms on the final map. Therefore, it is precisely at a cave's most difficult junctions that cross-sections are most useful and necessary.

Whenever you, as sketcher, find yourself pausing to figure out the best way to show a given feature on the plan view, be sure to draw a cross-section as well.Much in this same vein, cross-sections can offer opportunities to express cave features that just cannot be shown in a traditional plan view. For example, Chinn Springs Cave has several large, unruly helictite clusters that resemble upside-down fir trees. Sure, you can just write "grotesque helictite formations" next to the passage on your plan view… or you can draw a cross-section and show exactly what you mean.

The remedy for GCSS, indeed, is a counterattack.I've begun to seek out the most challenging and complex cross-sections to accompany my sketches. These not only help the cartographer, they are the most interesting and rewarding to draw. Hey, why just draw the shape of the tube at a given station when you can move 20 feet down the passage and draw that series of weirdo phreatic holes in the ceiling that you couldn't cram into your plan view?

The Caver's Perspective.

Of the different views presented in a typical cave map – Plan, Profile, and Cross-Section – the cross-section is unique in that it shows the "caver's

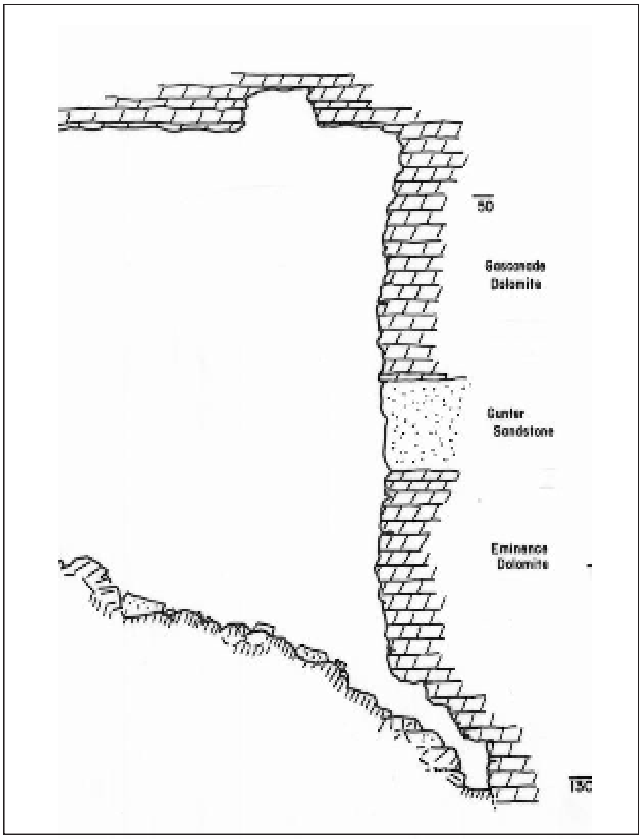


Above - In extraordinarily complex regions of a cave such as this one, it would be wholly impossible to express the vertical relationships between passages without these types of ambitious cross-section composites. Combining a dozen or more cross-sections in this fashion requires that each sketcher has been diligent about providing them. (Mick Sutton, Mammoth Cave, 1992)

perspective" of a cave passage. Ever try to find a poorly marked tiein to an existing cave survey without a cross-section?

It's difficult, because the cross-section bears the closest resemblance to the way we see cave passages while traversing them. This resemblance has a profound, direct effect on the usefulness of a cave map. Map users can relate to good cross-sections more readily than a plan view, the latter of which is more symbolic. In this respect, the crosssection becomes the opportunity for a sketcher or cartographer to explain what a passage is actually like. A 10' tall passage and a 100' tall passage might look the same in plan view, but they sure don't look the same in cross-section. More dramatically, a 6' tall passage filled with ankle-deep water might look the same in plan view as a 6' tall passage filled with neck-deep water, but the cavers making use of your map will thank you for the cross-section that lets them know what they're actually in for.

The first time I drew a cave map, I showed an in-progress version to a friend. It did not yet include cross-sections."So, is this walking passage over here?" he said, tapping a finger on a particular passage. The clearly visible ceiling height bubble, which noted the passage as being 1' high, told another story. I realized that,if sketching and drafting a cave map is a translation to a 2-dimensional format, then reading a cave map requires a similar bit of translation from 2 dimensions to the imagination of the viewer. After all, a height symbol is a perfectly acceptable way of expressing the vertical nature of a passage. Yet, much of the value of a cave map lies in how easily it can be understood by those who make use of it. The task of cartographer is not just to commit a cave to paper but also to make it easy for the viewer to



Above - This cartographer has utilized geologic information from the sketches and displayed it on the final map, both with USGS-standard lithologic patterns and notes describing specific strata. This is an advanced technique, requiring additional field work, but is of high value in some cases. (Scott House, Norris Cave, MO. 1986)

interpret and make use of. In this light, the map user can immediately relate to a cross-section, since it mirrors what they see while inside the cave.

Cross-sections, being drawn from the perspective of the caver, thus bridge this gap between symbols on paper and reality, and provide a recognizable reference for the end user. The different parts of an in-cave sketch combine not only to show what a cave *does* but what the cave is *like*, and cross-sections are the weapon of choice for describing the latter.

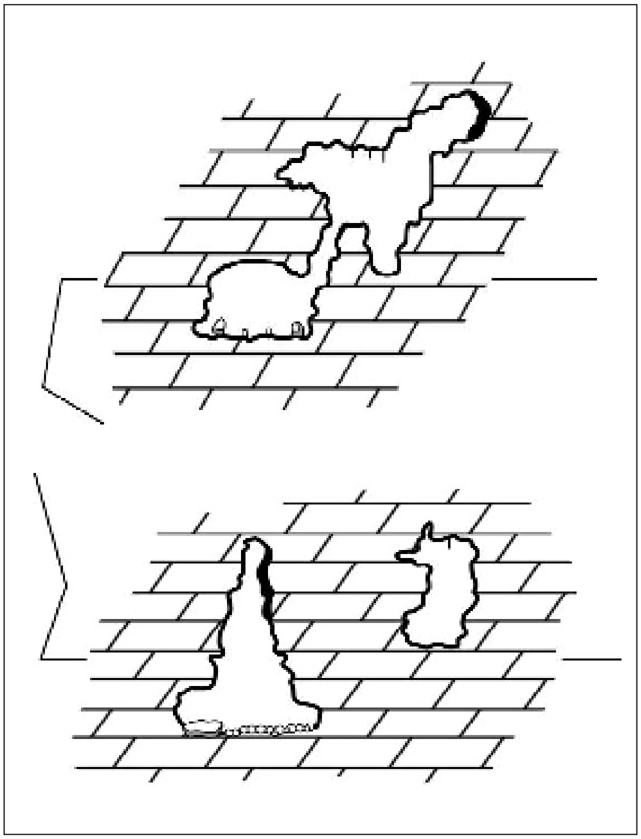
Passage Relationships.

In caves with adjacent passages or multiple levels, the best — and sometimes only — way to explain the relationship of passages to one another is to draw composite cross-sections. In complicated caves, especially those where multiple passages overlap each other along a common fault or vertical plane, this can be the only way to adequately illustrate their distribution. Where passages are especially dense, these representations can be truly mind-boggling, and even on simpler maps nothing compares to a good composite for explaining how, say, a room corresponds with a canyon above it.

In order for a cartographer to be able to composite cross-sections from multiple routes along a common plane, he or she must assemble single cross-sections from each into a whole. This is rarely done in-cave, as typically the nearby passage(s) have been surveyed separately (however, in instances where meanders deviate from a main passage and return to it, it's helpful for the sketcher to draw a composite to show the correlation between them). With a collection of crosssections from different surveys along the same plane, the cartographer can utilize the survey data in order to display the correct spacing between passages, providing a complete picture.This underscores the necessity for a sketcher to draw cross-sections frequently, and preferably at each station; with more available, the cartographer can successfully fuse the individual drawings without wasting manpower on trips to collect additional cross-sections in critical areas. Indeed, with enough cross-section instances available, the cartographer can opt for combinations at the most cartographically useful places, not just the places where he or she is lucky enough to have cross-sections that line up appropriately. It is, thus, critical in these situations that each sketcher provide an abundance of cross-sections.

Lithology.

It is critical to not only provide the shape of a passagebut to also include an indication of floor and wall materials.In the old days of "walls only" cave mapping,cross-sections followed suit, drawn as a single line andonly as descriptive as a silhouette.



Top - this type of passage is too complex in character to adequately describe with a plan view, and the LRUDs are likely useless; Bottom - even reasonably simple composites showing two adjacent passages express a wealth of information about the cave's nature.(Ben Miller, Barrow Cave, MO 2007)

However, moderncave survey techniques demand that the sketcher explainwhether, for example, a given wall is composed ofsolid limestone or whether it's an indeterminate jumbleof breakdown blocks. Simple symbols are used toshow which portions of a passage outline are sedimentor bedrock, and these "finish the thought" for the mapviewer as well as the cartographer working from yoursketches.

An even more detailed technique, where applicable,is show specific stratigraphic layers. This is not particularly common, and requires the sketcher to have knowledge of geology and the ability to observe the bedding planes; in some places, these are obvious to the layman (a chert layer or nodules jutting out of a wall, for example) while in others the difference between adjacent limestone formations can be gradational or otherwise indistinct.

However, in caves where the influence of multiple observable strata have had a major impact on speleogenesis, the extra effort may be well worth the trouble. The USGS publishes a PDF list of suggested lithologic patterns for common sedimentary rock on its website[1].

Methods.

Drawing cross-sections efficiently can be productive and satisfying. Once I've decided where to draw one, I add the leader lines and lightly define a box for width and height using the LRUDs[2]. Be sure to indicate which way the cross-section is facing, and include the leader lines to show its exact location and angle of direction. Next, sketch the outline of the passage, including those portions which may fall below water level. Some sketchers find it helpful, for sake of scale, to include a stick-figure caver in their cross-sections. It is also important not to make assumptions while drawing the outline. From *On Station,* by G. Dasher:

> *All cross-sections should be displayed open-ended whenever there was an indeterminate wall, a ceiling or ceiling alcove that was out of sight, or when the surveyors could not touch bottom in a swimming passage. Do not make up information that was not observed.*

Here is where you will add your passage features and lithology, drawing any breakdown blocks or formations as well as the composition of floor materials and bedrock walls. It's not important or necessary to meticulously draw each "brick" of the limestone symbol (*see the example at top left of page for a common in-cave "shorthand" version*), only to clearly depict which walls are actual walls and which are sediment, breakdown, cobble, etc.

Conclusion.

In summary, the best way to approach cross-sections is to go right for the throat; the more difficult they are, the more sorely they are needed. Good cross-sections not only augment a final map but engage its user, and the final product (composite or otherwise) is built on the shoulders of the individual cross-sections provided by each sketcher. As discussed throughout this article, the cross-sections are incredibly important for several different reasons, and warrant the same level of attention and care as your plan view. It's tempting to just scrawl the outline of short-changes the survey effort.

If you, too, suffer from Gutless Cross-Section Syndrome, make a conscious effort to draw them even in instances where you suspect it will be a pain in the ass, even if you already have two on that page and can't spare the room, even if it means you have to actually chimney up there to look and see where to draw that damned wall. The additional effort is worthwhile.

[1]*The Federal Geologic Data Committee's "Digital Cartographic Standard for Geologic Map Symbolization," specifically Section 37.1 relating to sedimentary lithologic patterns, can be found at http://ngmdb.usgs.gov/fgdc_gds/geolsymstd/fgdc-geolsym-sec37.pdf. In fact, the USGS provides pattern swatches for use with digital vector drawing programs; these can be downloaded toward the bottom of the web page at http://pubs.usgs.gov/tm/2006/11A02/. These patterns, not surprisingly, correspond to those shown on page 137 of On Station.*

[2]*Be cautious, as often the LRUD dimensions provided do not reflect the absolute limits of the passage. In other words, it may be 3' from the station to the floor, but that doesn't mean the point below station is actually the floor's lowest point. A little BS detection here goes a long way.*

The Effect of Binocular Vision Disorders on Cave Surveying Accuracy

Reprinted summary from BCRA Compass Points, March 2008 - summary from an article by Mark Dougherty – printed in Cave and KarstScience (vol. 33, no.2, pp 51-54)

Binocular vision disorders are relatively common and can have a detrimental effect on compass and clinometer readings taken with conventional sighting instruments unless suitable precautions are taken. This article sets out to highlight the effect on survey accuracy, and suggests practical measures that can be taken to mitigate their effects.

If a person has perfect binocular vision both eyes point in exactlythe same direction. A person whose eyes have a tendency to drift relative to one another in the absence of a visual cue to stay aligned has a phoria. This can clearly be a problem when using sighting instruments when one eye is focussed on the target station and the other is focussed on the scale of the instrument.

The most common phoria is heterophoria in which one of the eyes has a tendency to move in the horizontal plane. The condition is divided into two subclasses: esophoria and exophoria, which refer to the case where the eye drifts inwards or outwards respectively, as illustrated in Figure 1. If this disorder is sufficiently severe it can affect the accuracy of compass readings if it is not identified, but will have no effect on clinometer readings. Although the precise proportion of the population that suffer form this disorder to such a degree is unknown, the numbers appear to be significant.

Hyperphoria refers to the analogous (much rarer) disorder in which the eye drifts in the vertical plane. In this case, clinometer readings may be affected whilst compass readings will be correct.

The author suffers from fairly severe esophoria. When performing a sighting on a tree

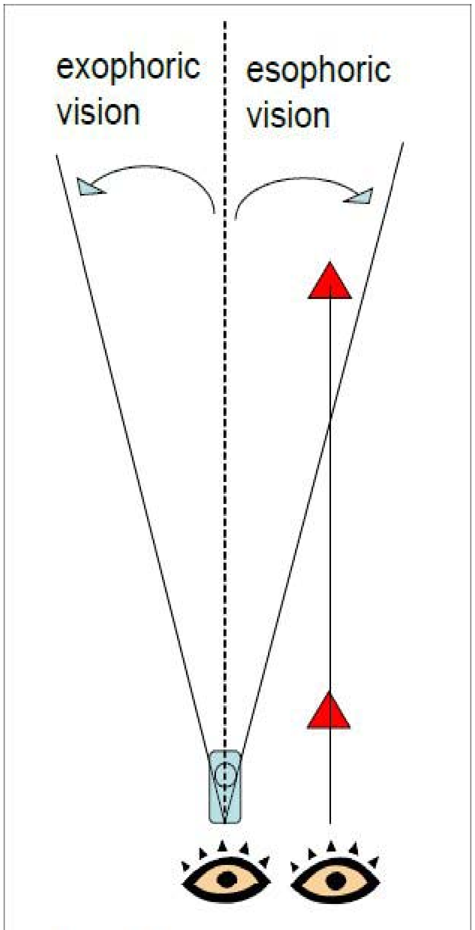


Figure 1: Exophoria and esophoria.

sighted at a distance of 15m, the difference between compass readings sighted with his right and left eyes was8°. This example provides an illustration of the potential scope of the problem. It is suggested that cavers should ideally test their eyes for heterophoria and hyperphoria by sighting compass andclinometer on a distant point with each eye in turn and looking for consistent differences between the readings. A number of simple methods for coping with the problem present themselves.

measure each leg twice, once with each eye, and average the results;

turn your head on its side when reading the instrument that would be erroneously recorded such that the axis in which your eye drifts is always in line with the rotation axis of the instrument;

sight with one eye over the top of the instrument;

wait until the reading has fully stabilised before recording it, since for people with a mild phoria the eye eventually stabilises on the direction parallel with the other eye.

The use of instruments with a built in laser sight that has to bealigned on the distant station also eliminates the problem.It may be tempting to assume that the issue can be addressed by performing an instrument calibration to determine the magnitude of the problem, then noting the eye with which each reading was taken during the survey and applying the appropriate correction.

However, the angle of convergence or divergence is not constant and can vary according to several factors.

The problem is often worse under high illumination levels, so if calibration is performed in bright sunlight the corrections obtained may not be applicable to readings taken underground. It is therefore advisable to perform calibration in lower lighting conditions that more closely approximate those experienced in the cave.

Tiredness can exacerbate the effect, so that the error increasesover the course of a long surveying trip.

The amount of convergence or divergence between eyes may be variable on the distance to the sighting object. The author found that the 8° difference when sighting on an object 15m distant was reduced to 4° when sighting on a closer target 3m away.

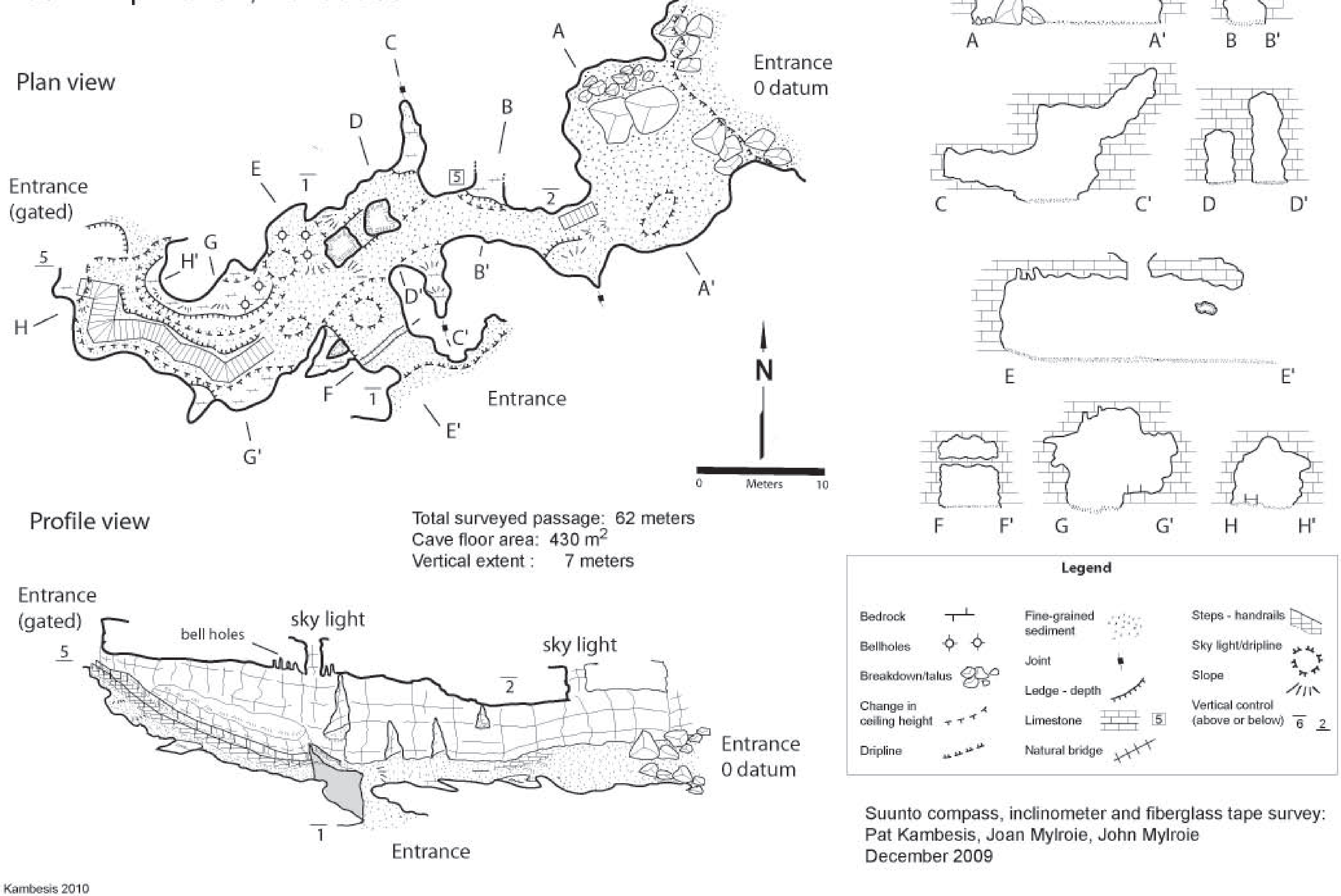
Overall, it is clear that using one of the methods to mitigate the effect of a phoria is preferable to relying on calibration readings. If it becomes apparent that a someone with a phoria has operated instruments in a cave, it may be possible to correct for the effects if they perform a calibration on multiple targets at different sighting distances under subdued lighting conditions. The correction can only be applied if it is known that the surveyor generally sights with one eye or the other so that the correction can be applied in the right direction.

The author concludes that binocular vision disorders are potentially a very serious source of errors in cave surveying if they are notidentified and their effects mitigated. He suggests that the following clause be added to the notes that supplement the BCRA surveying grades:

"To obtain grade 5, the surveyor(s) reading the instruments must be either known to not suffer from binocular vision disorders, or active precautions against such errors must be made."

Stairstep Cave

St. Philip Parish, Barbados



Total surveyed passage: 62 meters
Cave floor area: 430 m^2
Vertical extent : 7 meters

Suunto compass, inclinometer and fiberglass tape survey:
Pat Kambesis, Joan Mylroie, John Mylroie
December 2009

Kambesis 2010